

## **CLAIMS**

### **What is claimed is:**

1. A computer graphics processing system comprising:  
a graphics processor;  
a computer memory responsive to the graphics processor, the computer memory including an image depth buffer and a hierarchical image depth buffer, the hierarchical image depth buffer containing data items that identify a nearest depth value and a farthest depth value for a plurality of image depth buffer entries associated with a plurality of corresponding pixels.
2. The computer graphics processing system of claim 1, wherein the hierarchical image depth buffer further comprises a nearest depth value corresponding to a set of background pixels, the set of background pixels forming a subset of the plurality of corresponding pixels.
3. The computer graphics processing system of claim 1, wherein the hierarchical image depth buffer further comprises at least one flag.
4. The computer graphics processing system of claim 1, wherein the data items value within the hierarchical image depth buffer that identify the nearest depth value and the farthest depth correspond to a set of foreground pixels.
5. The computer graphics processing system of claim 1, wherein the size of the hierarchical image depth buffer is substantially less than the size of the image depth buffer.

6. The computer graphics processing system of claim 1, wherein the size of the hierarchical image depth buffer has a size that is less than one-fourth the size of the image depth buffer.

7. The computer graphics processing system of claim 1, wherein each entry in the hierarchical image depth buffer corresponds to a set of sixteen entries in the image depth buffer.

8. The computer graphics processing system of claim 1, wherein the graphics processor includes pixel visibility detection logic, the visibility detection logic having access to the data items of the hierarchical image depth buffer.

9. The computer graphics processing system of claim 1, further comprising a central processor, a memory controller, and a system memory, the graphics processor coupled to the memory controller and responsive to the central processor.

10. A computer graphics method for use in rendering a portion of an object onto a two-dimensional image plane, the computer graphics method comprising:

identifying a selected pixel corresponding to the portion of the object to be rendered;

reading data items from a hierarchical image depth buffer, the data items including a near depth value and a far depth value, the hierarchical image depth buffer associated with a plurality of depth values for a set of pixels, the set of pixels including the selected pixel; and

performing a comparison between the selected pixel and the data items to make a pixel visibility determination.

11. The computer graphics method of claim 10, further comprising rendering the selected pixel when the pixel visibility determination indicates a pixel visibility condition.

12. The computer graphics method of claim 11, further comprising writing the rendered pixel into a frame buffer associated with an image to be displayed.

13. The computer graphics method of claim 10, further comprising discarding the selected pixel when the visibility determination indicates a pixel occlusion condition.

14. The computer graphics method of claim 10, further comprising reading an entry from a depth buffer for the selected pixel and comparing the entry from the depth buffer with the selected pixel to determine visibility of the selected pixel, when the pixel visibility determination is non-determinative.

15. The computer graphics method of claim 10, further comprising updating at least one data item within the hierarchical image depth buffer.

16. The computer graphics method of claim 10, wherein the data items includes a flag and further comprising a step of checking a status of the flag.

17. The computer graphics method of claim 10, wherein the data items includes a flag and further comprising the step of updating a status of the flag.

18. A computer graphics processing system comprising:

- an image depth buffer;
- a hierarchical image depth buffer, the hierarchical image depth buffer containing a plurality of entries, each of the plurality of entries associated with a plurality of depth values within the image depth buffer; and
- a processor having access to the image depth buffer and to the hierarchical image depth buffer, the processor including a computer graphics routine for use in rendering a portion of an object onto a two-dimensional image plane, the computer graphics routine comprising:

- identifying a selected pixel corresponding to the portion of the object to be rendered;

- reading an entry from the hierarchical image depth buffer, the entry containing a set of data items, the set of data items of the hierarchical image depth buffer associated with a plurality of depth values within the image depth buffer, the plurality of depth values for a set of pixels, the set of pixels including the selected pixel; and

- performing a computation with respect to the selected pixel and the set of data items, to make a pixel visibility determination.

19. The computer graphics processing system of claim 18, wherein the set of data items includes a near depth value and a far depth value for the set of pixels.

20. The computer graphics processing system of claim 18, wherein the set of data items includes a near depth value and a far depth value for a foreground subset of the set of pixels, the foreground subset identifying pixels associated with a first object.

21. The computer graphics processing system of claim 18, wherein the set of data items includes a near depth value for a background subset of the set of pixels, the background subset identifying pixels associated with a background image.

22. The computer graphics processing system of claim 18, wherein the set of data items includes a flag for each pixel in the set of pixels a flag set identifies a corresponding pixel that has been rendered.

23. The computer graphics processing system of claim 18, wherein a first pixel in the set of pixels is within a first object to be rendered, a second pixel in the set of pixels is within a second object to be rendered, and a third pixel in the set of pixels is within a third object to be rendered.

24. A memory for use with a computer graphics processing system, the memory comprising:

an image depth buffer containing a plurality of image depth values;

a hierarchical image depth buffer, the hierarchical image depth buffer containing a plurality of entries, each of the plurality of entries associated with a set of the plurality of depth values within the image depth buffer, the set containing more than one depth value, at least one of the entries containing a near depth value and a far depth value corresponding to the set of the plurality of depth values.

25. The memory of claim 24, wherein the near depth value and the far depth value identify a foreground subset of the set of pixels, the foreground subset identifying pixels associated with a foreground object.

26. The memory of claim 24, further comprising a third level hierarchical buffer containing a plurality of initialization flags, each of the initialization flags for a super-block of pixels corresponding to a plurality of the entries within the hierarchical image depth buffer.

27. The memory of claim 26, wherein the initialization flags are cleared when the image depth buffer is initialized to a constant value.

28. A memory that includes an image depth buffer, comprising:  
a plurality of image depth values; and  
a hierarchical image depth buffer including a plurality of entries, each of the hierarchical depth buffer entries associated with a set of the plurality of depth values within the image depth buffer, at least one of the entries of the hierarchical image depth buffer including multiple near and far values, each near and far value corresponding to the plurality of depth values within the image depth buffer or to a subset of the plurality of depth values within the image depth buffer.

29. A memory that includes an image depth buffer, comprising:

a plurality of image depth values;

a hierarchical image depth buffer including a plurality of entries, each of the hierarchical depth buffer entries associated with a set of the plurality of image depth values within the image depth buffer, each of the entries of the hierarchical image depth buffer including at least two pairs of near and far values, each of the near and far value pairs corresponding to a set or subset of the plurality of depth values, each of the entries of the hierarchical depth buffer including a description of those members of the associated set of depth values corresponding to each pair of near and far values.

30. A memory that includes an image depth buffer, comprising:

a plurality of image depth values; and

a hierarchical image depth buffer including a plurality of entries, each of the hierarchical depth buffer entries associated with a set of the plurality of depth values within the image depth buffer, each of the entries of the hierarchical image depth buffer including at least one pair of near and far values and at least one unpaired near value, each of the entries of the hierarchical depth buffer including a description of those members of the associated set of depth values corresponding to either each pair of near and far values or to the non-paired near value.



31. A memory that includes an image depth buffer, comprising:  
a plurality of image depth values; and  
a hierarchical image depth buffer including a plurality of entries, each of the hierarchical depth buffer entries associated with a set of the plurality of depth values within the image depth buffer, each of the entries of the hierarchical image depth buffer including at least one pair of near and far values and at least one non-paired near value, each of the entries of the hierarchical depth buffer including a description of those members of the associated set of depth values corresponding to each pair of near and far values or to the non-paired near value, each of the entries of the hierarchical depth buffer including initialization information for the associated depth buffer entries and for related pixels.

32. A memory that includes an image depth buffer, comprising:  
a plurality of image depth values;  
a first level hierarchical image depth buffer including a plurality of entries, each of the first level hierarchical depth buffer entries associated with a set of the plurality of depth values within the image depth buffer; and  
a second level hierarchical image depth buffer including a plurality of entries, each of the second level hierarchical image depth buffer entries associated with a set of the plurality of the first level hierarchical image depth buffer entries and the associated image depth buffer values.